

Management of Brazilian Joyweed (*Alternanthera brasiliana*) in the Casuarina Coastal Reserve, Darwin, Australia

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Abstract

For the past 20 years, the only locality in the Darwin region in which Brazilian Joyweed (*Alternanthera brasiliana*) has been recorded outside cultivation is the Casuarina Coastal Reserve. This article documents its recent proliferation as ‘spot fires’ in disturbed and undisturbed woodland habitats in the central western section of the Coastal Reserve, as well as its spread to woodland at Charles Darwin University’s Brinkin campus on the southern extremity of the Coastal Reserve. Both are probably marginal or sub-optimal locations in terms of the species’ full range of habitats. This article also profiles Brazilian Joyweed’s identifying characteristics and ecology, in particular those aspects that make it an opportunistic invader, and management options in the Coastal Reserve. There, Brazilian Joyweed is spreading, outcompeting native species thereby threatening the ecosystem, and contravening the visual aesthetics of the Reserve. Brazilian Joyweed causes dermatitis and asthma in some people, and is not consumed by – that is, not controlled by – any vertebrate or invertebrate herbivore. These undesirable characteristics, when taken together, render its eradication in the Coastal Reserve and the University campus highly desirable. The populations in both localities should be, and indeed can successfully be, eliminated at the present time. However, the more wet seasons these populations remain unchecked, the harder eradication will become.

Introduction

This article is entirely the product of an amateur botanist driven by curiosity about an intriguing naturalised plant with a propensity for weediness.

Brazilian Joyweed is a member of the family Amaranthaceae in the higher group of flowering plants Magnoliophyta. It is known by a plethora of other common names besides Brazilian Joyweed – Alternanthera, Calico Plant, Indoor Clover, Joseph’s Coat, Joy Weed, Large Purple Alternanthera, Metal Weed, Parrot Leaf, Purple Alternanthera, Purple Joy Weed, Purple Joyweed, Ruby Calico Plant and Ruby Leaf. For simplicity, it is henceforth called just Joyweed in this article. Its scientific name is now agreed and accepted as *Alternanthera brasiliana* (L.) Kuntze, however until recently

it was known in the Northern Territory Herbarium's database under its synonym *Alternanthera dentata* (Mönch) Stuehlik ex R. E. Fr.; cultivar *rubra* (Ian Cowie, pers. comm.). This name, or at least just *Alternanthera dentata*, appears in the present Plan of Management for the Casuarina Coastal Reserve (Parks and Wildlife Commission of the Northern Territory 2002: Appendix 2).

Joyweed is native to (i.e. its original geographical range encompasses) southern Mexico, Central America (i.e. Belize, Guatemala and Nicaragua), the Caribbean and tropical South America (i.e. French Guiana, Guyana, Surinam, Venezuela, Brazil, Colombia, Ecuador and eastern Peru). Some reports state that, besides tropical America, it is also "native to tropical and subtropical regions of Australia" (e.g. Kumar *et al.* 2011: 41–43), but that statement is completely incorrect (Barker & Telford 2013). The error might have originated through confusion of the terms native and naturalised by scientists whose first language is not English. I am unable to track down the original source of this error, but it certainly should not be perpetuated. Joyweed has been widely transported by humans and cultivated beyond its original range, and is now naturalised (technically botanists use this term to mean this species has demonstrated the ability to reproduce in the wild unassisted by humans in places where it has been introduced beyond its original geographical range) in the southeastern United States of America (i.e. Florida), South Africa, India, some Pacific islands (e.g. Hawaii, Niue, Pitcairn Islands, Cook Islands, French Polynesia, and Palau), Singapore (Graham Brown, pers. comm.) and in tropical northern Australia. In tropical northern Australia it now occurs in the Kimberley region and the Top End (i.e. East Alligator River floodplain, Tiwi Islands and coastal communities out to, and including, Alyangula on Groote Eylandt) (Ian Cowie, pers. comm.) (Figure 1), as well as northern Queensland. Joyweed is cultivated in a few suburban gardens and schools in the Darwin region, but I have never seen it being sold at the Darwin markets as an ornamental plant or as a herb (pers. obs.). Indeed, it is not recommended by the Nursery and Garden Industry of the Northern Territory because it can quickly spread out of control (Nursery & Garden Industry Australia 2009).

Popular medicine has endowed Joyweed with numerous beneficial properties as treatments for coughs, diarrhoea, inflammation, infections, wounds, tumours, night blindness and hazy vision (Kumar *et al.* 2011). Western literature also demonstrates that Joyweed possesses many pharmacologically active chemicals that provide analgesia, improve wound healing, and have antitumour, immunosuppressant and antimicrobial activity (Kumar *et al.* 2011). Indeed, rigorous scientific experiments have elucidated the compounds responsible for this bioactivity (e.g. Barua *et al.* 2012). On the other hand, there are some negative effects. Contact with the plant causes asthma and dermatitis in some people. I experience dermatitis when brushing my skin against the 'flowers', and interestingly, the symptoms seem to be exacerbated on repeated contact.



Figure 1. Map of the northern half of the Northern Territory showing present distribution of *Alternanthera brasiliana*. Records are indicated by black triangles. Map, based on data in the Northern Territory Herbarium, courtesy Louis Elliott.

Identifying characters

Joyweed is a lax, soft-stemmed, shallow-rooted, perennial herb. It grows in a variety of soil types and habitats. Infestations in the Casuarina Coastal Reserve are most often noticed on the margin of dry woodland where it is conspicuous because of its rich maroon stems/leaves and vivid white 'flowers' (Figures 2–7). However, it can also thrive out of sight under deep shade in closed-canopy forest. In full sun and without support from neighbouring plants, Joyweed grows in a dense monospecific stand seldom exceeding 60 cm high. In contrast, in semi-shade and supported by the introduced Coffee Bush (*Leucaena leucocephala*) and/or the introduced vine Centrosema (*Centrosema molle*) and/or the native vine Supplejack (*Flagellaria indica*), it grows less densely but considerably taller (up to 2.5 m high). It is claimed it can grow to 4 m overseas (Institute of Pacific Islands Forestry 2010).

The stems (Figures 5, 7) are rounded with longitudinal ridges, and are rich maroon in colour. The nodes are (weakly to strongly) swollen, particularly on older plants, and the internodes are up to 15 cm long. The leaves are arranged on the stem in a decussate arrangement, that is, they are arranged in pairs opposite to those above or

below resulting in four vertical rows. The leaves are soft, simple and shortly petiolate with a distinct dorsal channel. The leaf blades are smooth, lanceolate to ovate, and each is drawn out into a long pointed tip. The leaves are maroon when the plant is growing in full sun, but dull greenish purple when in shade. The main veins on the undersurface of the leaves, including the marginal vein, are rich maroon like the stem, so the undersurface of a leaf looks maroon all over. Microscopic study reveals sparse (20–50 in total per leaf), irregularly scattered, maroon glands confined to the undersurface of the leaves. The stems and leaves have numerous, microscopic, straight (never barbed) white hairs.

The white, pea-sized (0.7–1 cm high) ‘flowers’, which resemble miniature button chrysanthemums, are the most interesting part of Joyweed because their apparent simplicity belies considerable complexity. The ‘flowers’ (Figures 6, 7) are really an aggregation of about 60 individual, bisexual, microscopic flowers and accompanying bracteoles. These flowers and bracteoles are arranged in tight, paper-rough, chaff-like groups (botanically correctly called cymes, and that term will be used in this context for the rest of this article with ‘flower’ referring to the individual flowers constituting the cyme). The cymes are on short stalks in the leaf axils and also on long apical stalks (up to 15 cm long). In other words, they are produced both axially and terminally on the same plant (Figure 3). A very small plant only 30 mm high will sport one single apical cyme (Figure 4).

Two bracteoles are present at the base of the flower (in the proper sense) itself, but they are not actually part of the flower. The bracteoles are stiff, upright, white, hairy, and sharply keeled (3.5 mm in length) with the upper edge jagged like a deeply toothed saw. The flower proper consists of five tepals (whether they are sepals or petals can only be determined by histological investigation so the neutral term ‘tepals’ is used for them) plus the androecium. The five tepals are identical, stiff, upright, hairy, and they measure 3 mm in length. Taken together, the tepals resemble a newly-opened tulip flower with the tips of the petals almost touching at the top. The androecium consists of five, sharply pointed, pale white stamens alternating with the brownish, short-stalked anthers (1 mm high) in a zigzag arrangement. The relatively large ovary is unilocular and it is pale green when unripe. As the seed ripens it becomes brown and the surrounding tepals also become dry and brown and quite tough, but they still shroud the brown seed in a ‘cocoon’. Eventually the whole flower (i.e. the seed plus the surrounding tepals) falls from the cyme. The bracteoles are not shed and they remain exactly as they were previously whilst other flowers higher up on the cyme become mature.

To test whether Joyweed yields any dyes in polar and non-polar solvents, the author diced stems, leaves and cymes coarsely, and immersed pieces separately in either boiling water or 100% ethanol. Only the stems produced a very pale pink dye after one hour’s immersion in boiling water.





Figure 2. *Alternanthera brasiliana* growing in partial shade with mature cymes. Note the small clump of Annual Mission Grass (*Cenchrus pedicellatus*) in the bottom right of the photograph. Casuarina Coastal Reserve, June 2013. (Neil Wright)

Figure 3. Single upper stem of *Alternanthera brasiliana* growing in partial shade showing leaves and mature cymes. Note the arrangement of the cymes with axillary ones being predominant on the lower section of the stem and terminal ones being predominant on the upper section of the stem. Charles Darwin University Campus, July 2013. (Neil Wright)

Figure 4. A very small plant of *Alternanthera brasiliana* only 30 mm high produces a single terminal cyme. Casuarina Coastal Reserve, June 2013. (Neil Wright)

Figure 5. When growing in full sun, *Alternanthera brasiliana* drops its leaves in the middle of the dry season as an adaptation to water loss. Casuarina Coastal Reserve, July 2013. (Neil Wright)

Figure 6. The 'flowers' of *Alternanthera brasiliana* consist of densely packed and highly structured groups of real flowers and bracteoles, hence they should be correctly called cymes. Casuarina Coastal Reserve, June 2013. (Neil Wright)

Figure 7. Detail of stem and two axillary cymes of *Alternanthera brasiliana*. Casuarina Coastal Reserve, June 2013. (Neil Wright)

Ecology

The following notes relate to the ecology of Joyweed in the Casuarina Coastal Reserve north of Darwin city. It is perennial, with individual plants living for at least 10 years (my estimation). Joyweed is an extreme opportunist, growing both in full sunshine on the margin of dry woodland and mown areas and under deep shade in closed-canopy forest. Vegetative growth frequently occurs at ground level from the base of the stem to produce a multi-stemmed shrub. The stems can develop adventitious roots from the nodes if they are covered with topsoil. Vegetative regrowth occurs readily from pieces of the stem that accidentally drop onto moist ground during the wet season, but it definitely does not occur during the dry season when the ground is rock-hard. Repeated mowing (or clipping in the case of garden plants outside the Reserve) results in a tight bushy shrub. Like mowing, trampling also induces further regrowth from the base of the stem. I have never seen any (vertebrate or invertebrate) predator eating Joyweed, or any signs of predation. Growth is extremely rapid following the first rain of the build up and during the wet season, but it halts completely during the dry season. Plants drop their leaves in the middle of the dry season, and they then consist only of leggy deep maroon stems supporting numerous white cymes (Figure 5). The full complement of cymes appears early in the dry season (May) and remains fertile throughout the dry season as cycle after cycle of flowers becomes mature within them. The cymes become brittle and detach easily as the dry season progresses (August to November). Therefore, the claim that flowers [i.e. cymes] “are seen throughout the year” (Smith 2011: 57) is certainly incorrect for the plants growing in the Coastal Reserve, though each cyme persists for up to eight months. The toughness of the cymes probably explains why they persist for so long. From my observations it seems that the seeds most often germinate close to the parent plant where they fall in their ‘cocoon’ composed of tepals, but they are certainly also spread by floodwaters; perhaps the tepalar ‘cocoon’ are buoyant? The presence of adults does not prevent the germination of seedlings underneath them, so generally several generations will be found growing side by side.

In the Casuarina Coastal Reserve, maximum density of Joyweed is about 100 plants per m² and this density is achieved along the margin of the dry woodland forest where it abuts mown areas. In deep shade along freshwater creek banks under the closed canopy of the native Satinash tree (*Syzygium nervosum*) where the ground is moister for longer, the density of Joyweed drops to about 5 plants per m². But, as mentioned above, those plants growing in shade can be four times the height of the plants growing in full sun so they have about the same number of cymes. Since no Joyweed plants were observed growing in saline soils as occur at the margins of the tidal creeks that drain into Sandy Creek, I assume it cannot tolerate any salinity.

In the woodland habitats in the Coastal Reserve, disturbance happens every day due to the activities of Orange-footed Scrubfowls (*Megapodius reinwardt*). These strong birds scrape down to 10 cm when foraging and even deeper when tending their massive

communal mounds. So nowhere in the Coastal Reserve can really be considered as undisturbed and thus unable to be colonised by Joyweed. Indeed, the largest patch of Joyweed (approx 0.07 ha in area) lies within the territory of a resident pair of Scrubfowls, and is also less than 200 m away from a massive Scrubfowl mound that is regularly tended by these unrelenting gardeners.

Dry season fires burn stems, leaves and cymes to destruction, but individual Joyweed plants can regenerate from the base of the stem at ground level.

In summary, Joyweed can certainly hold its own with the worst of the environmental weeds in the Casuarina Coastal Reserve. However, as for Lantana (*Lantana camara*) (pers. obs.), I think the Reserve mostly provides sub-optimal habitat for Joybush because of the Top End's extended dry season. During the dry months Joybush makes no vegetative growth and pieces of its stem cannot root if they fall onto the ground. Some Joyweed plants growing in full sunshine certainly do die completely towards the end of the dry season, even after they have dropped their leaves.

Management

The Casuarina Coastal Reserve Landcare Group (CCRLG) was formed in 1998. Its first priority was to remove the invasive weeds that were threatening the natural habitats in the Reserve, particularly the non-declared weed Coffee Bush and the declared weed Candlebush (*Senna alata*). These weeds were targeted for removal around a man-made enlargement of the permanently freshwater uppermost reach of Sandy Creek. This section of the creek receives almost all the stormwater from the suburb of Tiwi through a large drain that runs underneath Roeklands Drive. Following the campaign to remove these weeds during the dry season of 1998 and to replant the area with seedlings of native plants during the following wet season, the rehabilitated area received little attention as the philosophy was to let the native vegetation return on its own accord (Louise Finch, pers. comm.). One large fire devastated the northernmost plantings in 2009 and a smaller fire burnt the margin lightly again in June 2013. There was definitely no Joyweed in the area in 2001 (pers. obs), however when I revisited the area 11 years later (i.e. in June 2012) I discovered one large and dense patch of Joyweed centered at 12.3612°S, 130.8732°E. Searches revealed multiple smaller patches, mostly on the forest margin, southwest of this patch plus half a dozen small patches within small isolated tree 'islands' (mostly consisting of single *Illyriophila pubescens* trees) located about 5 m east of these patches, as well as multiple much smaller patches on the forest margin northeast to the CCRLG's 'Moth Block' site at 12.3574°S, 130.8756°E. Therefore, the total linear extent of Joyweed in this section of the Coastal Reserve is presently 0.68 km. Early in 2013, a further two patches were discovered 1 km southwest in woodland at the rear of the Charles Darwin University campus (centered at 12.3680°S, 130.8658°E and at 12.3702°S, 130.8664°E), where it is adjacent to the Coastal Reserve. At the time of writing, I have not undertaken a thorough survey of

the northern section of the Coastal Reserve for Joyweed, so I do not know if there are more patches around Lee Point or Buffalo Creek.

In the central western sections of the Casuarina Coastal Reserve with which I am familiar, the spread of Joyweed is mostly due to transport of seeds (inside their tepalar 'cocoon') when the ground is temporarily flooded during the wet season. However, additional spread has definitely occurred in patches that I liken to spot fires along the margin of the forest. It is likely that seeds are also moved by activities such as mowing and slashing, and even possibly transported by humans and dogs walking through the area. I am certain that no spread of seeds occurs by wind as the reproductive portions (i.e. the cymes themselves and the tepalar 'cocoon') are quite heavy. The question of seed viability remains open. Based on my 2012 trial removal (see below), I had concluded that the seeds can remain viable in the topsoil for no longer than one wet season, but the Internet site *Pacific Island Ecosystems at Risk* contains a communication from the experienced botanist Barbara Waterhouse that the seeds appear to have the ability to remain dormant for a long period (Institute of Pacific Islands Forestry 2010). The matter can be resolved by monitoring the plots in the Coastal Reserve from which flowering plants have been completely removed, which I intend to do.

Joyweed is regarded as an environmental weed in the Northern Territory (Smith 2011), as it is in northern Queensland and northern Western Australia. It has escaped cultivation and become naturalised, particularly along waterways in the warmer and wetter coastal areas of northern Australia. It is included in some environmental weed lists in eastern Queensland (e.g. in Ipswich City and in the Redland Shire) and is regarded as an emerging weed or 'sleeping weed' in the Katherine region (Queensland Government 2011). It is also seen as a threat to native ecosystems on Aboriginal lands in the Northern Land Council area (Smith 2002).

The only locality in the Darwin region at which Joyweed is recorded outside cultivation is the Casuarina Coastal Reserve. Beyond the Coastal Reserve, Joyweed is also recorded from Virginia in the Litchfield Shire (Figure 1; Ian Cowie pers comm., 2013), but the Herbarium's data are not comprehensive. The present Plan of Management for the Coastal Reserve (Parks and Wildlife Commission of the Northern Territory 2002: Section 9.5.3) does include *Alternanthera brasiliana* (under its synonym *A. dentata*) as a weed, but not a declared weed. That Plan aspires to manage the impact of weeds and also to develop strategies to manage weeds.

Despite most of the Coastal Reserve not being an optimal habitat (as argued above) for Joyweed, it is rapidly invading habitats that have been both 'disturbed' by human activities and fire and 'undisturbed' by humans. Its preference for moist soils and for locations alongside freshwater streams – its optimal habitat by my estimate – make it a real worry as it could potentially occupy all such habitats in the Reserve. Indeed, it could be argued that Joyweed has the potential to threaten the ecosystem within the entire Reserve. Observations at the Tiwi site have shown that the patches of dense

Joyweed have prevented the regrowth of seedlings of native plants. Individual plants tolerate fires by resprouting from the base of the stem, so fire is not effective in killing Joyweed. The vivid maroon swathe of Joyweed along the front of the woodland contravenes the aesthetics of the Reserve. On repeated occasions I have come across patches of Joyweed trampled by itinerants as they walk to and from their dry season drinking campsites in the Coastal Reserve, yet on no occasion have I ever seen any indication of them using the plant as a natural medicine. This despite its supposed healing qualities mentioned previously. And lastly, Joyweed is not eaten by or controlled by any (invertebrate or vertebrate) herbivore. All these undesirable attributes render its eradication from the Coastal Reserve and the University campus highly desirable.

Removal of Joyweed from the Coastal Reserve by hand pulling is possible at this time, but it will be a labour intensive and time consuming task. As a trial, a patch of Joyweed of mixed ages approximately 20 m² in area that was growing moderately densely in shade besides Tiwi Creek (centered at 12.3611°S, 130.8730°E) and had definitely never been subject to a targeted or general eradication campaign previously (pers. obs.) was completely removed by careful hand pulling in July 2012. This removal took about six hours of work. The initial removal required follow-up removal of newly-germinated seedlings and resprouted plants (see below) in March 2013, a task that only took one hour. That trial was made easier by the unusually dry wet season of 2012/2013 with almost no flooding, so consequently there was little spread of seedlings from elsewhere. During the trial it was noted that plants that had snapped off at ground level when they were being pulled out (a frequent occurrence) readily resprouted from the base of the stem. Therefore, it is essential to pull the roots out as well as the stems during hand removal.

My observations on Joyweed in the Coastal Reserve can be extrapolated to other localities and parts of Australia with different climatic regimes. I know it is a pessimistic conclusion, but seemingly nothing can control this weed in those tropical and subtropical regions that experience warm climates and moist soils year round!

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